1906MNRAS..66..118W

Table III.

Light Curve of RV Lyræ.

Time.	Brightness Before Min.	After Min.	Time.	Brightness Before Min.	After Min.
h m			h m		
4 00	49·0	50·6	1 50	74·5	76·7
3 50	49·5	52·0	1 40	76·0	77·9
3 40	51·0	53·6	1 30	77·5	79·0
3 30	53·2	55·6	1 20	78·7	79·9
3 20	55·4	57·7	1 10	79·7	80·7
3 10	58·0	59·9	1 00	80·5	81·2
3 00	60·5	62·5	0 50	81·1	81·6
2 50	62·6	64·7	0 40	81·7	82·0
2 40	65·3	67·0	0 30	82·0	82·1
2 30	67·4	69·3	0 20	82·2	82·2
2 20	69·2	71·4	0 10	82·3	82·3
2 10	71·2	73·5	0 00	82·4	82·4
2 00	72·8	75·1			

The brightness of the variable according to the light-scale of Table I. is given for every ten minutes of time before and after minimum in the above table. The normal brightness of the star is 49·0 of the scale, corresponding to 11·06 mag. The minimum brightness is 82·4 = 12·73 mag. There is no stationary period at minimum. The table shows a slight though distinct difference in the form of the curve before and after minimum. The star appears to take a little longer in recovering its light than it did in losing it. The difference is, however, not great, and may perhaps be only subjective.

Hove: 1905 *December* 26.

Elements and Light Curve of VW Cygni (Ch. 7268).

By A. Stanley Williams.

$$\text{R.A.} = 20^{\text{h}}\ 09^{\text{m}}\ 37^{\text{s}} \quad \text{Decl.} = +34^{\circ}\ 03'\!\cdot\!7\ (1855)$$
$$\text{,,} \quad = 20\ 11\ 21 \quad \text{,,} \quad = +34\ 11\cdot8\ (1900)$$

Preliminary elements of variation of this Algol-type variable star have been published in the *Astronomische Nachrichten*, No. 3899, the period being there given as 8·4326 days. The minima of this star are difficult to observe, owing to the long duration of the stationary period (7 hours). In fact I have not

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yet been able to observe a minimum in a complete manner; that is, to observe both the decreasing and increasing phases on the same night. Hence an outline of the manner in which the improved elements of variation and the light curve have been derived may not, perhaps, be without interest.

The comparison stars used and the adopted light scale are given in Table I., together with the assumed stellar magnitudes of the stars, based on the assumptions that the star *a* is 8·2 mag. and the value of a step is 0·05 mag. The adjoining little chart

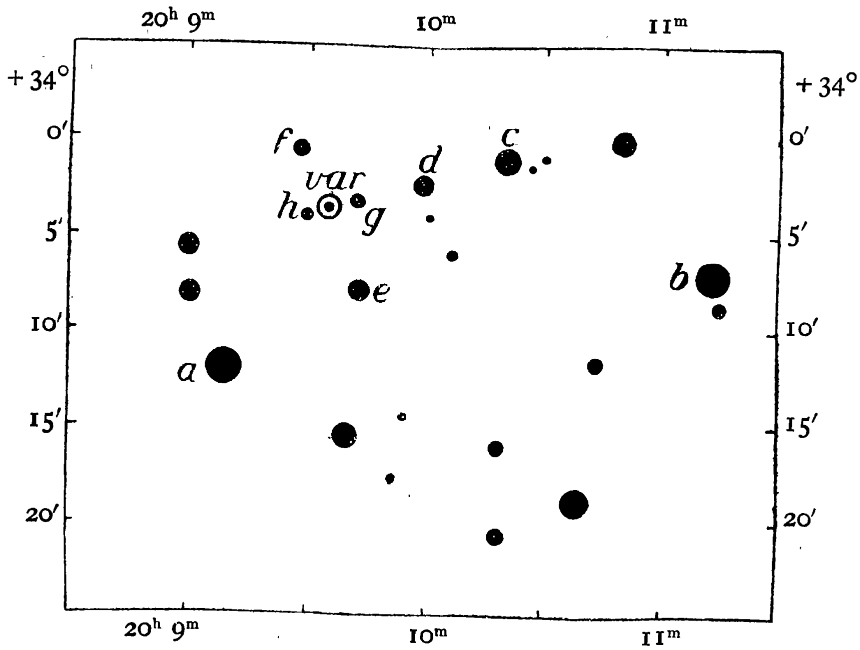

Chart of the Region of *VW Cygni.*

(for 1855) will assist in identifying the comparison stars and the variable. The fainter stars have, however, only been inserted in this by estimation.*

TABLE I.

Comparison Stars and Light Scale.

Star.	B.D. No.	B.D. Mag.	Light.	Assumed Mag.
a	+34°3936	8·5	80·0	8·20
b	+34°3953	8·7	65·8	8·91
c	+34°3946	9·2	52·3	9·58
d	+34°3942	9·5	41·8	10·11
e	...	...	37·8	10·31
f	...	...	26·5	10·87
g	...	...	12·5	11·57
h	...	...	2·5	12·07

* The B.D. positions of two or three of the stars shown on the chart are apparently slightly in error. In particular the B.D. declination of the star *c* would appear to be about $\frac{2}{3}'$ too small, and that of the star *d* about $\frac{2}{3}'$ too large.

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There are eight minima available for the purpose of deriving an improved value of the period of variation.* On two nights the star was observed during the decreasing phase, and on the remaining six nights during the increasing phase. Since the star was never observed during both phases on the same night, it is impossible to determine the point of minimum, or the middle of the stationary period, directly from the observations. As there is an interval of only two periods between the two observations of the decreasing phase, these two observations are of little use for determining the period of variation. It was necessary, therefore, to rely in the first place upon the six observations of the increasing phase. A rough † light curve (Curve A) had already been formed from the early observations of 1903, and by means of this curve the times (T_2) when the variable was of brightness 20 on the light scale of Table I. were carefully determined. This brightness 20 was chosen because it was roughly near the average brightness of the observations made during the increasing phase. The times (T_1) when the variable was of corresponding brightness were also determined for the two minima observed during the decreasing phase. Table II. contains the observed times of T_2.

TABLE II.

Observed and Computed Times of T_2.

E.	Observed T_2.	Computed T_2.	O–C. d
80	J.D. 2416340·39	6340·379	+0·011
89	6416·24	6416·255	– ·015
115	6635·44	6635·450	– ·010
124	6711·34	6711·326	+ ·014
173	7124·43	7124·425	+ ·005
175	7141·28	7141·286	– ·006

The above observations on a least-square reduction gave $8^d{\cdot}4306$ as the corrected period of variation. The computed times of T_2 and the residuals O – C will be found in the table. The mean of the times T_2 is J.D. 2416728·187. The two observations of T_1 were then reduced to the same date, the mean of the two being J.D. 2416727·759. The mean of the times T_1 and T_2 was assumed to be the time of minimum, so that the improved elements (Elements II.) reduced to E = 0 are :

$$\text{Minimum} = \text{J.D. } 2415665{\cdot}717 + 8^d{\cdot}4306\ \text{E}$$

* Four observations made during the minimum which occurred on the night of 1903 September 7 are of no use for this purpose, since they all relate to the long stationary period.

† This curve differs only slightly from the light curve (C) contained in Table III.

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All the good * observations (60 in number) made when the star was below normal brightness were then reduced with these elements, and a fresh light curve (B) drawn on the assumption that the increasing and decreasing phases were exactly similar. This was rendered necessary owing to the fact that there are still two considerable gaps where there are no observations available. But it appeared that the observations would be somewhat better represented by a slight departure from exact similarity in the increasing and decreasing phases, and a few local corrections were accordingly made, resulting in the third light curve (C), which is given in Table III., where the brightness of the star is stated according to the light-scale of Table I. for every half-hour before and after minimum.

Table III.

Light Curve of VW Cygni.

Time.	Brightness.		Time.	Brightness.	
	Before Min.	After Min.		Before Min.	After Min.
h m			h m		
10 30	45·2	45·2	5 00	19·6	20·0
10 00	45·0	45·0	4 30	15·8	16 1
9 30	44·0	43·0	4 00	11·7	11·9
9 00	42·0	41·0	3 30	6·5	6·5
8 30	39·5	39·0	3 00	6·5	6·5
8 00	37·0	37·0	2 30	6·5	6·5
7 30	34·4	34·8	2 00	6·5	6·5
7 00	31·8	32·6	1 30	6·5	6·5
6 30	29·0	30·0	1 00	6·5	6·5
6 00	26·1	27·0	0 30	6·5	6·5
5 30	23·0	23·5	0 00	6·5	6·5

The above light curve must be very near the true one, though there are no observations at present during the first part of the decrease and again at the end of the stationary period and the commencement of the increase. The middle point of the stationary period has been assumed to be the minimum point, and the times of minimum † have been determined by means of the above light curve, and are given in Table IV.

* A few observations made under unfavourable circumstances were rejected.

† These are geocentric Greenwich mean times, the correction for the light equation not having been taken into account in the present investigation.

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1906MNRAS..66..118W

TABLE IV.

Observed and Computed Times of Minimum.

E.	Observed Minimum.	d	h m	J.D. 241 +	Computed Minimum.	O−C. h m
0	1901 Oct.	7	13 28	5665·561	5665·7220	(−3 52)
79	1903 Aug.	4	17 39	6331·735	6331·7394	− 6·3
80		13	4 13	6340·176	6340·1700	+ 8·6
81		21	14 20	6348·597	6348·6006	− 5·2
89	Oct.	28	0 53	6416·037	6416·0454	− 12·1
115	1904 June	3	5 44	6635·239	6635·2410	− 2·9
124	Aug.	18	3 17	6711·137	6711·1164	+ 29·7
173	1905 Oct.	5	5 05	7124 212	7124·2158	− 5·5
175		22	1 44	7141·072	7141·0770	− 7·2

The period of variation was then redetermined from the observed times of minimum, the finally adopted elements of variation (III.) being as under:

$$\text{Minimum} = 1901 \text{ Oct. } 7,\ 17^{h}\ 20^{m}\ (\text{G.M.T.}) + 8^{d}\ 10^{h}\ 20^{m}\ 04^{s}\ E$$
$$= \text{J.D. } 2415665{\cdot}722 + 8^{d}{\cdot}4306\ E$$

There is no difference from the elements II. so far as the length of the period is concerned, and only a slight shift in the epoch of minimum. The computed times of minimum and the residuals O−C will be found in the table. The residuals seem to be quite satisfactorily small, considering the circumstances of the case.

The observation of 1901 October 7 is a photographic one. The star must have been at or very near its minimum brightness at the time of this photograph, but owing to the long duration of the stationary period this observation is of no use for correcting the elements, beyond showing that the period can hardly be any shorter than that adopted.

The normal brightness of the variable is 45·2 of the light scale = 9·93 mag., and the minimum brightness 6·5 = 11·87 mag. The duration of the stationary period is $7^{h}\ 0^{m}$, and the whole duration of the eclipse phase $20^{h}\ 30^{m}$. The long duration of the stationary period is somewhat interesting, and it would seem that one of the two component bodies is both larger and fainter than the other one. There is no indication of the existence of any secondary minimum.

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1906MNRAS..66..118W

On a Method of Determining the Absolute Dimensions of an Algol Variable Star. By Alex. W. Roberts, D.Sc.

I. *Introduction.*

The present paper deals with an extension of the problem of Algol variation in the direction of a determination of the absolute dimensions of a close binary star.

Although the more definite and more accurate consideration of the dimensions of such systems falls more properly within the area of spectroscopic research, yet, theoretically at least, the light-curve of any eclipse variable exhibits data which when properly discussed yield a determination of the absolute size of the system.

The theory that underlies this important determination is the simple one that light takes an appreciable interval of time to traverse the orbit of a binary star.

A moment's reflexion will make it evident that this circumstance must make itself manifest as an acceleration in the apparent occurrence of both the primary and secondary maximum phases. The time of passing the primary and secondary maxima will, however, remain unchanged; that is, the approach and recession of the component stars relative to the Earth as they revolve round one another will be translated, owing to the measurable velocity of light, into a corresponding hastening and retardation of the successive phenomena of eclipse.

It will be clear, therefore, that if we had the means of ascertaining the light-curve of an Algol variable with perfect precision and completeness, and if all the phenomena of eclipse were capable of geometrical explanation and exposition, then, at all times, the light-curve of the system under consideration would provide sufficient data for a definite determination of the absolute dimensions—size, mass, and density of the eclipsing stars.

It will require little acquaintance with the many perplexities of variable star curves to assure one that, while in theory the problem of determining the dimensions of a binary star from an examination of its light changes has the merit of simplicity, in actual practice the solution is one beset with difficulties and obscured by uncertainties.

(1) It is not possible to determine the light-curve of a close binary star with the accuracy and refinement necessary for a numerical solution of the problem, except in cases where the variable completes its full period in a few hours.

In the latter circumstance the intervals between the four cardinal phases of variation, principal minimum, principal maximum, secondary minimum, secondary maximum, can be determined to within a minute of time. This is a quantity sufficiently refined to indicate, at least, a major limit to the size of the star.

(2) If all the phenomena of variation are to be included in a

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